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ABSTRACT

This document presents laboratory safety rules for Arkansas K-12 schools which were developed by the Arkansas Science Teachers Association (ASTA) and the Arkansas Department of Education (ADE). Contents include: (1) "Laboratory Safety Guide for Arkansas K-12 Schools"; (2) "Safety Considerations"; (3) "Safety Standards for Science Laboratories"; (4) "Laboratory and Classroom Sizes"; (5) "Designing a Classroom and Lab"; (6) "Fire Extinguishers"; (7) "Storage Facilities"; (8) "Legal Concerns"; and (9) "Laboratory Safety Procedures." (YDS)

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Laboratory Safety Guide for Arkansas K-12 Schools

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Arkansas Department of Education

1998-99

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The Arkansas Department of Education wishes to thank the following Arkansas Science Teachers Association's 1998 Board members for writing and editing this guide.

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Special thanks to Bill Fulton, Science Specialist, Arkansas Department of Education for the management of this guide.

Laboratory Safety Guide for Arkansas K-12 Schools

This guide was developed by the Arkansas Science Teachers Association (ASTA) and the Arkansas Department of Education (ADE) for the public schools of the state. The guide contains recommendations; however, following them does not remove from the school district or the teacher their responsibility for safe practices.

The first section gives guidance on school facilities, State Board of Education Guidelines, Federal Safety Rulings, and general safety precautions. The second section contains guidelines for grade levels, special needs, and science disciplines. The Appendix contains sample forms schools may find useful to school science safety.

This guide may be duplicated, separated into grade levels and disciplines and/or given to each teacher of science within a district. However, each teacher needs to be familiar with the entire content of the guide. There is some very important information in the first section that all teachers need to know. The primary grade sciences are held under the same safety guidelines as the upper grades. Each school building should hold meetings to discuss the content of this guide.

Twenty percent of the instructional time for all science courses or units for kindergarten through high school grades will contain activities and laboratory experiences. School districts should provide scientific and safety equipment needed to meet the learner expectations in the Science Framework. A listing of recommended scientific equipment can be found on the Arkansas Science Teachers Association's web site at: <http://www.aristotle.net/~asta/index.htm>.

Required science courses for High School Graduation beginning with the high school graduating class of 2002:

Science - 3 units. At least 1 unit of biology or its equivalent (ABC I and II) and 1 unit in a physical science. All required science units must provide hands-on laboratory experience for students a minimum of 20% of instructional time.

Needed science courses for the Arkansas Academic Challenge Scholarship and Unconditional Admission to an Arkansas Public College or University beginning with the high school graduating class of 2002:

Three science units, with laboratories, chosen from physical science, biology, chemistry, or physics. Only one unit may come from a life science.

The Arkansas Department of Education used Dwight D. Eisenhower Professional Development grant funding to print and distribute this guide. The Arkansas Science Teachers Association would like to thank the Council of State Science Supervisors, who sent copies of their state safety guides to aid in the development of this guide.

Safety Considerations

In a science classroom and lab, students will use a variety of equipment, chemicals, or living organisms that may be potentially dangerous. Safety cannot be left to chance. Each school administrator and teacher must be safety-minded at all times. Teachers must set the example for students by modeling safety rules. Provisions that promote safety should be developed in planning facilities, instruction, and purchasing and updating equipment.

This national standard is different from our state standards. The Arkansas Standards for Accreditation states, "The student/teacher ratio for kindergarten shall be no more than twenty (20) students to one (1) teacher in a classroom. However, kindergarten class size maximum may be no more than twenty-two (22) with a one-half time instructional aide being employed for those classes. The average student/teacher ratio for grades one through three in a school district shall be no more than twenty-three (23) students per teacher in a classroom. There shall be no more than twenty-five (25) students per teacher in any classroom."

"The average student/teacher ratio for grades four through six in a school district shall be no more than twenty-five (25) students per teacher in a classroom, and no more than twenty-eight (28) students per teacher in any classroom."

"In grades seven through twelve, a teacher shall not be assigned more than one hundred fifty (150) students daily; and an individual academic class shall not exceed thirty (30) students, provided that, in exceptional cases or for courses that lend themselves to large group instruction, these ratios may be increased." (From "Standards for Accreditation, Arkansas Public Schools Revised May 1993, Standard V-B).

Standard science classroom and laboratory designs usually feature 12 workstations for 24 students with general two students per workstation. Teachers should be able to see and monitor the activities of every student from a single central location.

Today's teachers and school administrators need to be aware of chemical storage, handling, and disposal issues, "Chemical Right to Know" laws, laboratory designs, first-aid guidelines, special needs of some students, as well as scheduling of science classes to facilitate learning and to protect students and valuable equipment.

Each science teacher needs a laboratory in his/her classroom or should have access to a lab nearby. If a lab must be shared, the science teachers involved should devise a fair schedule. It is recommended that only science classes be scheduled in laboratories and science classrooms. This provides safety for students, protection of expensive equipment and facilities, and adequate preparation time for science teachers.

Even a well-equipped science lab is not useful to a science teacher if other classes are scheduled into the lab. Science teachers need time to set up laboratory experiments during their preparation period and must be able to leave those experiments in the room during the day. They also need the opportunity to clean up after labs. If a science teacher has three different science preparations (or more) and needs to set up science experiments for each of these classes, the science laboratory must be unoccupied during their prep time. Each teacher needs his/her own room and should never have to float from room to room. It is virtually impossible to continuously move science equipment and supplies in a timely, safe, and economical manner.

Similar science classes should be scheduled in clusters. It is difficult to set up a physics lab one period, clear it out of the way, set up a chemistry lab, remove it for a biology lab, followed by another physics lab. Classes should be scheduled so that the labs can be planned in a coherent fashion.

Safety Standards for Science Laboratories

The 1988 Science Safety Standards, adopted by the Arkansas Department of Education, have been updated and clarified. Schools should use the following standards to improve their science programs.

1. A functional fume hood, emergency shower, eye wash (15 minutes of potable water that operates hand-free) station, aprons, protective gloves, splash resistant goggles, and fire blankets must be in the chemistry laboratory.
2. All science laboratories should contain functional safety equipment appropriate to their use that may include the equipment in number 1 plus fire extinguishers, safety charts, and first-aid kits. Safety goggles and protective gloves should be furnished for all students and teachers when needed.
3. All students must wear protective aprons and splash resistant goggles when using chemicals. Protective gloves are required when working with strong acids, bases or heated materials that could damage unprotected skin.
4. All students must wear latex or other protective gloves (if latex sensitive) when touching preserved biological specimens. While fixatives kill most diseases, there are viruses that affect humans that are not necessarily killed by the preservative. Some old specimens may be preserved in formaldehyde (gloves and protective mask must be worn if these are touched). Schools should make every effort to switch to non-formaldehyde preservatives. It is also prudent to wear gloves during dissection to reduce the chances of spreading blood-borne diseases if a student is accidentally cut.
5. All chemicals must be labeled with the name of the chemical on the container and segregated to separate incompatible types. Each school building must maintain an inventory of their laboratory chemicals along with Materials Safety Data Sheets.
6. Chemicals must be kept under lock and key. They must be stored on a non-corrodible surface in a cabinet or storage shelf. Flammable or corrosive chemicals should be placed in cabinets designed for this purpose.

7. Chemical storage rooms in the chemistry laboratory should be locked and must have a ventilation purge fan (four air changes per hour) to the outside air. Isolate the chemical storage exhaust from the building ventilation system.

A SUMMARY OF ARKANSAS ACT 556 of 1991
PUBLIC EMPLOYEES CHEMICAL RIGHT TO KNOW

1. Post the Chemical Right to Know" notice in a conspicuous place.

2. Have an inventory list of all hazardous substances at the facility.

3. Get a Material Safety Data Sheet (MSDS) for each substance on the inventory list. Make sure any MSDS for in-stock chemicals are current and up-to-date. The MSDS should have a date of preparation and all spaces should be completed.

4. Label containers of hazardous substances with the identity and the appropriate hazard warning (There are a few exceptions to this rule).

5. Prepare a written hazard communication program. The program should describe how the employer is going to implement the requirements of the regulation. These should be kept in the school administration office.

6. Employees must have access to the collection of MSDSs, the written program, and the inventory list of hazardous substances.

7. Train employees on the following information:

   a. requirements of the law itself;

   b. employees rights under the law;

   c. use the MSDSs to get further information;

   d. details of the employers hazard communication program;

   e. hazards of the jobs that the employees will be doing (Be sure to include the hazards of non-routine jobs such as maintenance work.); and

   f. employees can protect themselves against the hazards associated with their jobs.

8. Inform contractors of the hazards they will be working with while on the employer's premises.

9. Record of trainings must be maintained that includes the names of employees attending the training sessions and the dates of attendance. These records should be kept in the school office.

Laboratory and Classroom Sizes

Due to greater emphasis on laboratory activities and group work, more materials are necessary and more space is needed. The following minimum standards apply:

Science Lecture Rooms (K-12)	750 Square Feet
Science Lecture with separate but connected Lab	1500 Square Feet as an Aggregate Total
Multi purpose Science Lecture & Laboratory (10-12)	1500 Square Feet
Multi purpose Science Lecture & Laboratory (7-9)	900 Square Feet
Chemical Storage	100 Square Feet
Regular Storage	100 Square Feet

The most useful multi purpose science classroom/laboratories are a minimum of 1500 square feet and a maximum of 1800+ square feet with a chemical storage of 100-150 square feet and regular storage of 100-150 square feet.

Ninth grade physical science lab activities require larger space. Schools preparing to build new physical science classrooms and laboratories should consider rooms ranging 1500 square feet and a maximum of 1800+ square feet.

Regular elementary classrooms should be 750 square feet. However, elementary schools in the process of building science classrooms should use the larger (1500) minimums as found above.

All laboratories should be designed with safety as a priority. If schools are planning a new lab they should have two exits clearly marked to assure safe egress in the event of an emergency.

The design should enable teachers to supervise all students from any point in the room.

Schools in the earthquake zone should bolt all cabinets and storage units to the walls and floor.

The room should have an efficient air conditioning system that will purge the air to the outside 8 times an hour.

Aisles and doorways should be clear of obstructions and be wide enough to allow passage of wheelchairs and other equipment for handicapped students.

Chemical storage should be vented (power ventilators are recommended that force air to the outside four times during an hour).

The sinks in such work areas should be 8 feet apart, with one work area per two pupils.

A fume hood and an emergency shower are required whenever chemistry or physical science is taught (umbrella shaped showers are preferable).

Designing a Classroom and Lab

Flinn Scientific has an excellent web site on science and safety at: < http://www.flinnsci.com/>. Ask what science classrooms and labs will look like in 20–25 years and use the following ideas in designing your science classrooms and labs;

Design a lab space that can be used for all sciences. Flexibility in design is absolutely critical.

Computers and the use of technology will increase. Make sure you have space and easy access to run additional cable in future years.

Design a lab where the teacher can see all the students at work simply by standing in one place and turning around. Easy access to all students is critical.

Try to keep the lab and classroom separated. Do not design a lab that uses perimeter lab stations with desks stuck in the middle. While this is the most common lab design, it is also the least creative and causes all kinds of problems for both teachers and students.

Be creative in your design. Visit schools and see what unique designs they have developed. Take your camera to remember the ideas. Remember creative does not have to mean expensive.

Lastly, select an architect who has designed and helped to build school science labs. Experience in building and designing science labs will save you both time and money.

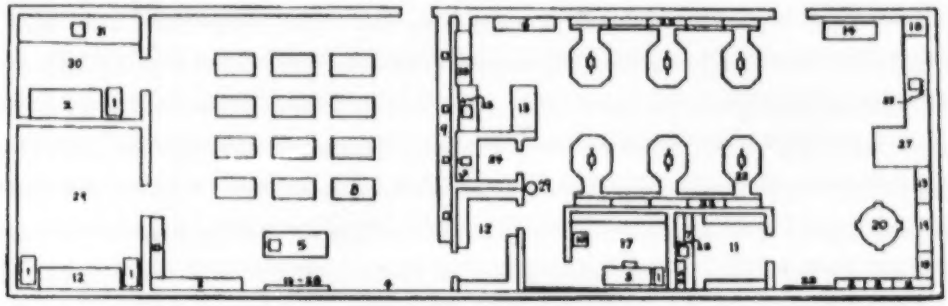
Be active in the design process. Know your priorities and communicate them to all involved.

Be prepared. If you are planning on designing a science lab two years from now, you should start your planning now.

The following are **example designs for science classrooms** with attached laboratories (see http://www.aristotle.net/~asta/safety.htm for other examples):

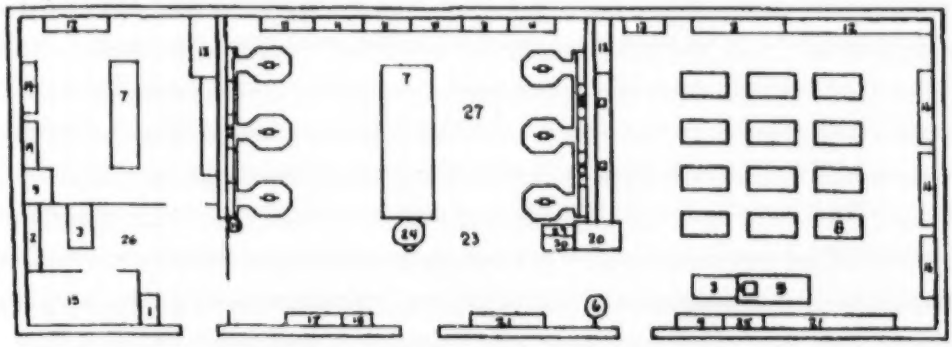
Biology

1. File cabinet
2. Bookshelf
3. Teacher's desk
4. Bulletin board
5. Demonstration desk
6. Herbarium
7. Preparation room
8. Student desks (24/lab)
9. Perimeter work area
10. Refrigerator
11. Chemical storage
12. Non-chemical storage
13. Autoclave
14. Plantmobile
15. Display cases
16. Chalkboard
17. Lab offices
18. Soil bin
19. Microscopes and models
20. Research area (computers)
21. Lab cart
22. Lab workstations
23. Overhead storage
24. Animal room/vivarium
25. Drying racks
26. Tray storage
27. Base cabinet storage
28. Screen
29. Fire extinguisher & first aid kit
30. Teacher's office
31. Teacher's computer



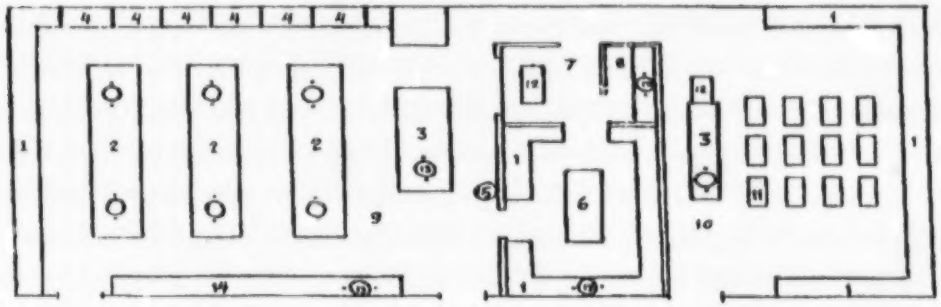
Chemistry

1. File cabinet
2. Teacher's computer
3. Teacher's desk
4. Bulletin board
5. Demonstration desk
6. Shower
7. Lab work table
8. Student tables (seating 24)
9. Refrigerator
10. Chemical storage
11. Fume hood w/gas and water
12. Cabinet/storage
13. Sink
14. Shelf
15. Darkroom
16. Charts
17. Periodic chart
18. Safety charts
19. Fire extinguisher
20. Eye wash
21. Chalkboard
22. Lab workstations gas/water/electricity
23. Teacher's desk
24. Distilled water
25. Screen
26. Teacher's office
27. Laboratory
28. Classroom
29. Fire blanket/first aid kit
30. Research area (computers)



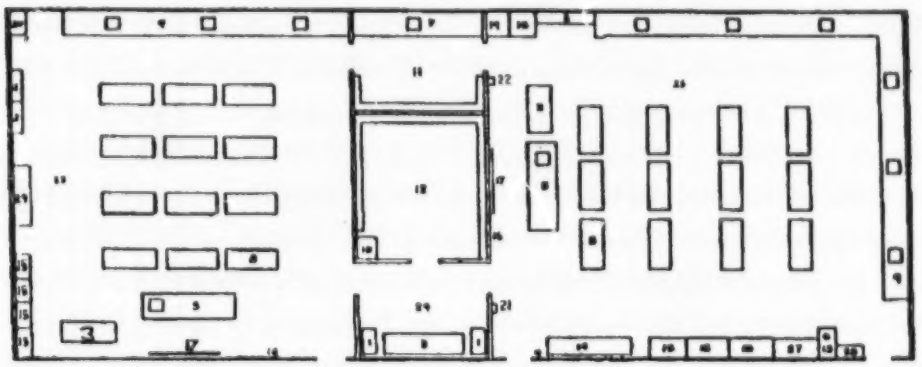
Physics

1. Cabinets with countertop
2. Lab tables with gas, water, & electricity
3. Demonstration table
4. Cabinets with storage & display
5. Storage & preparation room
6. Work table
7. Teacher's office
8. Darkroom and storage
9. Laboratory
10. Classroom
11. Student tables for 24 students
12. Teacher's desk
13. Sink with gas, water, & electricity
14. Research area with computers
15. Fire extinguisher/first aid



Multi-Purpose Science Lecture and Lab

1. File cabinet
2. Book shelf
3. Teacher's desk
4. Bulletin board
5. Demonstration desk
6. Shower and eye wash
7. Preparation table
8. Student desk (24)
9. Perimeter work areas
10. Refrigerator
11. Non-chemical storage
12. Chemical storage
13. Fume hood
14. Plantmobile and herbarium
15. Display cases
16. Chalkboard
17. Screen
18. Model case
19. Skeleton case
20. Aquarium
21. Fire extinguisher
22. Fire blanket
23. Fire blanket
24. Teacher's office
25. Classroom
26. Laboratory
27. Animal cases
28. Plant press
29. Rock collection
30. Research area (computer)



Fire Extinguishers

Fire extinguishers should be of the proper classification and easily accessible during emergencies. In most cases, the best extinguisher is the tri-class ABC-type. Extinguishers should be placed in the science rooms and labs.

The multipurpose ABC-type dry chemical fire extinguisher covers all fire classes, except for reactive and combustible metals, such as sodium, lithium, potassium, magnesium, and certain metallic hydrides and alkyls. Fire classes are defined below:

- Class "A"--Fires in wood, textiles, and other ordinary combustibles containing carbonaceous material. This type of fire is extinguished by cooling with water or a solution containing water (loaded stream), which wets down material and prevents glowing embers from rekindling. A general-purpose dry chemical extinguisher is also effective by its smothering action.

- Class "B"--Fires in gasoline, oil, grease, paint, or other liquids that gasify when heated. This type of fire is extinguished by smothering, thus shutting off the air supply. Carbon dioxide, dry chemical, and foam are effective on this type of fire.

- Class "C"--Fires in live electrical equipment. This type of fire is extinguished by using a non-conducting agent. A carbon dioxide extinguisher smothers the flame without damaging the equipment. A dry chemical extinguisher is also effective. Whenever possible, the source of power to the burning equipment should be cut off.

- Class "D"--This specialized classification is suitable for fires in combustible metals such as magnesium, titanium, zirconium, sodium, potassium, and others. A special extinguisher powder, unlike regular dry chemical and general-purpose dry chemical, may be applied by scoop. Dry sand may also be used to extinguish small class "D" fires.

Storage Facilities

Proper storage policies are essential to the safe operation of any laboratory. Below are some precautions that should be taken into consideration:

- Laboratory chemicals should be kept under lock and key.

- Chemical storage areas should be well ventilated and lighted. It should be properly ventilated (power vent) to the outside (four complete air changes per hour).

- Separate storage cabinets should exist for flammables, solvents, and corrosives. The storeroom should be properly ventilated to assure that fumes are not allowed to exceed hazardous or explosive limitations and that temperatures are maintained within safe ranges 55 ^{0}F- 85 ^{0}F. Such ventilation should be active (electrical forced air that pumps fumes out of the storeroom to create air movement, and to reduce temperatures). Storerooms should be as cool as, or cooler than, the classroom or laboratory during the summer.

- The two most well known chemical storage plans are found in the Flinn Scientific Chemical Catalogue/Reference Manual (http://www.flinnsci.com/) or the Safety Guide in the Fisher Scientific Catalogue (http://www.fishersci.com/). Schools should use one of these plans and design their storage rooms accordingly.

- The chemical storage area should be secured at all times when not in use, with access only to authorized school staff with documented proper training.

- Flammable and dangerous chemicals should be locked in a fire-resistant cabinet.

- Flammable or toxic gases should be stored at or above ground level and not in basements.

- All gas cylinders should be secured against falling over and should be stored away from heat sources.

- All chemicals should be adequately labeled, segregated to separate incompatible types, and stored alphabetically within those groupings.

- A fire extinguisher should be immediately accessible. (The tri-class ABC type covers most fires.)

- Mixing or transferring chemicals should not be permitted in the storage area.

- Storage areas should not have blind spots.

- Open flame, smoking, or any other type of heat should not be permitted in the chemical storage area(s).

- Cleanliness and order should be maintained in the storage area at all times.

Legal Concerns

Teachers are legally liable if students have suffered injury as a result of their inadequate supervision. The degree of supervision expected depends partly on the age of the student. A teacher must stop an experiment or arrange for a qualified substitute to be present before leaving the lab.

There are two types of defenses commonly used in the U.S. in tort law, namely "contributory negligence" (where the defendant may not collect any damages if he/she were a contributory cause) and "comparative negligence" (where different percentages of the damages are assigned to defendant and plaintiff). The state of Arkansas allows a "mixed comparative negligence" defense, where the damages assigned to the plaintiff can be collected only if the defendant is held more than 50% responsible.

It would be to the advantage of the teacher to document the fact that students have been instructed in proper safety rules (such as requiring a perfect score on the safety quiz before allowing a student to begin lab work and by keeping copies of students' safety quizzes). Simply posting rules is not sufficient. If students are only repeatedly cautioned about breaking rules (for example, failure to wear eye protection) and are not dismissed from lab work, such a practice actually reveals that a particular rule is not in effect (see sample safety rules, contracts and incident forms in the Appendix).

Professional publications, such as journals from the American Chemical Society (ACS) and the NSTA, include safety notes and updates. The ACS offers free single copies of safety publications. The *Journal of Chemical Education* (ACS) and *The Science Teacher* (NSTA) each include regular features on lab safety and teachers would be expected to be familiar with developments when published. (From "Safety Manual: A Primer for High School Chemistry Teachers," Dr. Michael W. Rapp, Professor of Chemistry, University of Central Arkansas, Conway, July 1997).

Laboratory Safety Procedures

Established safety procedures are essential to any effective safety program. Recommended procedures must be understood and practiced by teachers and students if accidents are to be minimized. The procedures listed in this section cover major areas in science teaching; however, these procedures are not "absolutes" and should be interpreted with reason.

These guidelines can be used as an effective checklist for evaluating the science safety program.

General Lab Safety

- Always perform an experiment or demonstration prior to allowing students to replicate the activity. Look for possible hazards. Alert students to potential dangers. Safety instructions should be given orally and be posted each time an experiment is begun.

- Constant surveillance and supervision of student activities are essential.

- Never eat or drink in the laboratory or from laboratory equipment. Keep personal items off the lab tables.

- Never use mouth suction in filling pipettes with chemical reagents. Use a suction bulb.

- Never "force" glass tubing into rubber stoppers.

- A bucket of 90% sand and 10% vermiculite, or "kitty litter" (dried bentonite particles) should be kept in all rooms in which chemicals are either handled or stored. The bucket must be properly labeled and have a lid that prevents other debris from contaminating the contents.

- Smoke, carbon monoxide, and heat detectors are recommended in every laboratory. Units should be placed in the laboratory and related areas (storerooms, preparation rooms, closets, and offices).

- Use heat-safety items such as safety tongs, mittens, aprons, and rubber gloves for both cryogenic and very hot materials.

- A positive student attitude toward safety is imperative. Students should not fear doing experiments, using reagents, or equipment, but should respect them for potential hazards. Students should read the lab materials in advance noting all cautions (written and oral).

- Teachers must set good safety examples when conducting demonstrations and experiments. They should model good lab safety techniques such as wearing aprons and goggles.

- Rough play or mischief should not be permitted in science classrooms or labs.

- Never assume that an experiment is free from safety hazards just because it is in print.

- Closed-toed shoes are required for labs involving liquids, heated or heavy items that may injure the feet.

- Confine long hair and loose clothing. Laboratory aprons should be worn.

- Students should avoid transferring chemicals they have handled to their faces.

- Never conduct experiments in the laboratory alone or perform unauthorized experiments.

- Use safety shields or screens whenever there is potential danger that an explosion or implosion of an apparatus might occur.

- Proper eye protection devices must be worn by all persons engaged in, supervising, or observing science activities involving potential hazards to the eye.

- Make certain all hot plates and burners are turned off when leaving the laboratory.

- Frequent inspection of the laboratory's electrical, gas, and water systems should be conducted by school staff.

- Install ground fault circuit interrupters at all electrical outlets in science laboratories.

- A single shut-off for gas, electricity, and water should be installed in the science laboratory. It is especially important that schools in the earthquake zone in the Arkansas Delta have such a switch.

- MSDS sheets must be maintained on all school chemicals. Schools should maintain an inventory of all science equipment.

- Laboratories should contain safety equipment appropriate to their use such as emergency shower, eye-wash station (15 minutes of potable water that operates hands free), fume hood, protective aprons, fire blankets, fire extinguisher, and safety goggles for all students and teacher(s).

- Protective (rubber or latex) gloves should be provided when students dissect laboratory specimens.

- New laboratories should have two unobstructed exits. Consider adding another to old labs if only one exist.

- There should be frequent laboratory inspections, and an annual verified safety check of each laboratory should be conducted by school staff.

- All work surfaces and equipment in the chemical or biological laboratory should be thoroughly cleaned after each use.

- Students should properly note odors or fumes with a wafting motion of the hand.

- Chemistry laboratories should be equipped with <u>functional</u> fume hoods. Fume hoods should be available for activities involving flammable and/or toxic substances.

- The ACS and OSHA believe that contact lenses do not pose additional hazards to the wearer and that <u>contact lenses are allowed when appropriate eye and face protection are used</u>. The wearing of contact lenses in the science laboratory has been a concern because of possibility of chemicals becoming trapped between the lenses and the eye in the event of a chemical splash.

- All laboratory animals should be protected and treated humanely.

- Students should understand that many plants, both domestic and wild, have poisonous parts and should be handled with care.

- Criteria for scheduling special needs students into laboratory classes should be established by a team of counselors, science teachers, special education teachers, and school administrators. Aides or special equipment should be made available to the science teacher.

First-Aid and Emergency Tips

- Have first-aid procedures established and posted in the event of an accident.

- All students and teachers should know both the location of and how to use fire extinguishers, eye-wash fountains, safety showers, fire blankets, first-aid kits, and other safety equipment.

- Safety signs should identify the location of safety equipment.

- Teachers and their aides should be fully aware of potential hazards and know how to deal with accidents. It is recommended that each school district have its K-12 science teachers receive science lab safety training.

- Emergency instructions concerning fire, explosions, chemical reactions, spillage, and first-aid procedures should be conspicuously posted near all storage areas.

- Safety posters are required in science classrooms.

- All lab incidents must be reported to the school administration on the day of the incident. A written description should be submitted to the administration within 5 working days.

Chemical Disposal

Two excellent sources of information about laboratory safety and disposal are The Laboratory Safety Workshop and Flinn Scientific. Flinn's *Chemical & Biological Catalog/Reference Manual* is free when requested on school stationery. Their safety site can be found at http://www.flinnsci.com/sindex.html. One particularly helpful web site is http://www.che.ilstu.edu/ChemSafety/index.htm and is maintained by the Department of Chemistry at Illinois State University.
For disposal considerations, the Flinn catalog is a good reference. A more complete reference is "Hazardous Chemicals Information and Disposal Guide," 3rd ed., by M. A. Armour et al. The

cost of disposal of unwanted chemicals is such that the teacher is much better advised to use smaller amounts or to substitute lab exercises that avoid disposal problems.

If a school needs to dispose of unwanted or unknown (no label) chemicals, call or write the Hazardous Waste Inspector Supervisor, Arkansas Department of Pollution Control and Ecology, 8001 National Drive, Little Rock, AR 72209, (501) 682-0874. Be prepared to give the name or description of the chemical, amount, type of container, nearest landfill and local sewage system. A Request for Assistance in Disposal of Waste or Hazardous Chemicals form has been provided in the Appendix.

Some Inappropriate Chemicals in Schools

The following is a list of some chemicals that are so hazardous that they are not suitable for use in most public schools. A high school teacher choosing to use any of these or similarly hazardous chemicals must possess the necessary skill and provide the proper conditions to ensure their safe use and disposal. (From "Safety Manual: A Primer for High School Chemistry Teachers," Dr. Michael W. Rapp, Professor of Chemistry, University of Central Arkansas, Conway, July 1997).

ammonium perchlorate - explodes when heated, strong oxidizer
aniline - highly toxic, suspect teratogen, allergen
arsenic & its compounds - toxic, suspect carcinogens
benzene - suspect carcinogen, flammable, toxic
benzoyl peroxide - explodes when heated, strong oxidizer
bromine (element) - highly toxic, oxidizer
cadmium & cadmium compounds - suspect carcinogens, toxic
carbon disulfide - highly flammable, toxic, suspect teratogen
carbon tetrachloride - suspect carcinogen, toxic
chloroform - suspect carcinogen, toxic
chromium & its compounds (e.g., ammonium dichromate) - suspect carcinogen, toxic, irritant
cyanides - highly toxic
dimethylformamide - suspect teratogen, unstable
diethyl ether (ethyl ether, or ether) - highly flammable, unstable (peroxides)
dimethysulfoxide (methyl sulfoxide) - suspect teratogen
formaldehyde - highly toxic, suspect carcinogen
formic acid - corrosive, toxic
hydrofluoric acid - highly toxic, causes deep burns
lead compounds - toxic, irritant, suspect carcinogens
mercury & mercury compounds - highly toxic, irritants
methyl alcohol - highly toxic, highly flammable
perchloric acid - strongly corrosive, strong oxidizer
peroxides - unstable
phosphorus (white and yellow) - highly toxic, flammable
picric acid - unstable (dry), irritant, corrosive
potassium - flammable solid, unstable with age

Primary, Elementary, and Middle Grades

Primary through middle grade schools are held accountable for all rules and regulations that govern laboratory safety in Arkansas junior and senior high schools. This includes chemical use, storage and disposal, behavior in the classroom, use of safety equipment and safety skills, handling and treatment of lab animals and plants, use of electricity, science equipment, demonstrations, etc.

- Provide careful supervision of students at all times during science laboratory activities.
- Teacher should be familiar with the local school's policy and procedure in case of accidents. If such a policy does not exist, one should be developed.
- The recommended group size of students working in lab activities should be limited to the number that can safely perform the activity without danger of accidents. Groups of two are recommended for K-4 and a maximum of three for grades 5-6.
- Instruct students about potential hazards and precautions to be taken at the beginning of each lab.
- All spills should be cleaned up immediately.
- Teach all students that chemicals should not be mixed just to see what may happen.
- Establish routine procedures for the use of eye protection requiring all students to wear safety goggles whenever conducting labs or activities that involve laboratory chemicals, sharp objects, or materials that could end up in someone's eye.
- Use blunt scissors in the primary grades.
- Students should not put any object or material into their mouths. They should not taste or sniff anything during a science activity or lab. They should keep hands away from their eyes, ears, nose, and mouth when working with plants, animals, chemicals or unknown substances. Students should wash their hands after each lab.
- Students should not connect the two terminals of dry cells or storage batteries.
- Do not use mercury thermometers in the elementary grades. Use alcohol or other types of thermometers.
- Batteries or cells of 1.5 volts or less are safe for elementary classroom use. However, the battery may explode if heated or thrown into an open fire. The chemicals inside the battery can be dangerous if taken internally or exposed to the skin.

- Students should not bring live or dead animals to the classroom (they may transmit disease to other animals). Many times students think that a small animal has been abandoned by its parent when this is not the case.

- Discourage students from bringing personal pets to the classroom to prevent animal-to-animal disease transfer. If a pet is brought in, it should only be handled by its owner, and provisions made for the care of the pet during the day by the owner.

- Lab animals must have properly designed living quarters and a supply of food and water. Students should never tease animals nor insert their fingers or other objects into the animals cages.

- Students should not touch poison ivy (poison oak). Both have similar compound leaves of three leaflets.

- Students should not touch most wild mushrooms nor place them in their mouths. Some poisonous plants to avoid eating are: elephant ear, pokeweed, foxglove, jimson weed, apple seeds, buckeye, daffodil bulbs, English ivy berries and leaves, four o clock roots and leaves, holly berries, hydrangea leaves and buds, iris, lily of the valley leaves and flowers, mayapples, milkweed, mistletoe berries, nightshade, osage orange sap, philodendron leaves, poinsettia, potato or tomato leaves, privet leaves and berries, Virginia creeper berries.

Students with Special Needs

The school leadership must make sure that a strong working relationship exists between the special education staff and other curriculum staff. A team approach is necessary in working with students with special needs.

- Discuss shared information with the special education staff.

- Be aware of all barriers, both physical and psychological, to your special needs students. Work with the special education staff to remove potential barriers.

- Do not under estimate the capabilities of special needs students.

- Become familiar with your rights and the rights of your special needs students in your classroom.

- The hearing impaired depend heavily on visual perception.

- Visually impaired students learn primarily through hearing, but other sensory channels are important.

- Use a multisensory approach in teaching all students.

Biological Sciences Concerns: Junior and Senior High Schools

- Never use a scalpel or cutting device with more than one cutting edge.
- Teachers should be aware of students who are sensitive to biological preservatives.
- Gloves and goggles should be worn during dissection of preserved specimens. Watch for skin reactions to latex gloves.
- Specimens should be properly supported when being dissected. Never dissect a handheld specimen.
- Only nonpathogenic bacteria should be used in the classroom. Indiscriminate culturing and handling of pathogenic or nonpathogenic organisms are discouraged.
- Petri dish cultures should be sealed with tape or paraffin.
- Bacterial cultures should be killed before washing petri dishes. Most cultures can be killed by heating for 20 minutes at 15 pounds/inch^2 of pressure or use a sterilizing solution. Volumes greater than 100 ml require longer heating times. If cultures are spilled, spray with disinfectant, and let stand for 15 minutes before wiping up.
- Contaminated culture media containers should be sterilized with a strong disinfectant and washed with a strong cleaning agent (5% Lysol). Wash counter tops with a 10% solution of bleach to disinfect.
- Always flame wire loops prior to and after transferring microorganisms.
- Wear proper equipment (apron, goggles, and rubber or latex gloves) when washing or handling bacteriological or chemical ware.
- Use utmost caution when using a pressure cooker or autoclave. Turn off the heat source, remove the cooker, and allow the pressure to gradually reduce to normal atmospheric pressure prior to removing the cover.
- Never transfer liquid media or other solutions with a mouth pipette.
- Use proper illumination for microscopes. Reflected sunlight can damage the eye.

- Under no condition should potassium cyanide be used as the killing agent in insect-killing jars. If alcohol or ether is used as the killing agent, students should be warned of their flammability and toxicity.

- Human fluids (blood, saliva, urine, etc.) should not be used in science activities. Appropriate simulated fluids can be purchased from science suppliers.

Physical Sciences Concerns: Junior and Senior High Schools

- Proper protective devices (eyes, body) should be used when hammering, chipping or grinding rocks, minerals or metals.

- Splash resistant goggles should be worn when working with laboratory chemicals.

- Direct viewing of the sun should be avoided at all times.

- Direct viewing of infrared and ultraviolet light sources should be avoided at all times.

- Never allow the open end of a heated test tube to be pointed toward anyone.

- Volatile liquids (alcohol, etc.) should be used in very small quantities away from open flames and in a well-ventilated room. Such substances should be heated electrically or in water baths.

- Broken or chipped glassware should not be used.

- Gases, especially in high concentrations, can be very dangerous. Carbon dioxide is no exception, as unconsciousness can result within seconds if high concentrations are breathed. Breathing pure nitrogen, argon, helium, or hydrogen is dangerous.

- Chemicals should not be tasted for identification purposes.

- When heating materials in glassware by means of a gas flame, the glassware should be protected from direct contact with the flames through use of a wire gauze or heat-resistant centered wire gauze.

- Do not pour water into concentrated acid.

- The teacher should remove broken glass in sinks promptly, as it presents a serious hazard.

- Use a fume hood whenever dealing with highly volatile, toxic fumes.

- When working with flammable liquids:
  - Have a CO_2 or multipurpose fire extinguisher available.
  - Work in a well-ventilated area.

- Keep the liquid over a pan or sink.
- Use no flames or high-temperature heating devices.
- Do not store in a home-type refrigerator. Fumes may be ignited by sparks produced in the electrical switching system. (Explosion-proof refrigerators are available from science supply houses.)

- Students should understand that the human body is a conductor of electricity.

- Students should be taught safety precautions regarding the use of electricity in everyday situations. For example, use of high voltage AC such as 110-volt line can be extremely dangerous.

- Students should be cautioned against unsupervised experiments with electric current on home or school circuits.

- Work areas, including floors and counters, should be dry.

- Never handle electrical equipment with wet hands or when standing in damp areas.

- Never overload circuits.

- To prevent severe shocks, discharge electrical condensers and Leyden jars before handling.

- Water and gas pipes are grounded. Never touch a ground, such as water and gas pipes, and an electrical circuit simultaneously.

- Do not use electrical wires with worn insulation.

- Electrical equipment should be properly grounded. Use 3-prong service outlets. A ground-fault circuit breaker is desirable for all laboratory AC circuits. A master switch to cut off electricity to all stations is desirable for all laboratory AC circuits.

References

American Chemical Society - Committee on Chemical Safety, Safety in the High School (1987) Special Issue of *Chemunity*, ACS, 1155 Sixteenth St. NW, Washington, D.C. 20036.

Armour, M.A. et. al., Hazardous Chemicals Information and Disposal Guide (1987). (available for about $25 from Lab Store, 3888 N. Fratney, Milwaukee, WI 53212)

Council of State Science Supervisors, School Science Laboratories: A Guide to Some Hazardous Substance, U.S. Consumer Products Safety Commission, Washington, DC, 1984.

Fisher Scientific, Fisher Safety Guide, 4901 W. LeMoyne St., Chicago, IL 60651 (phone 1-800-621-4769).

Flinn Scientific Inc., Chemical & Biological Catalog/Reference Manual, Flinn Scientific, Inc., P.O. Box 219, Batavia, IL. 60510-0219 (phone 1-800-452-1261).

Kaufmann, Jim, "Speaking of Safety: The Laboratory Safety Workshop Newsletter," (three yearly issues/$10) avail. from The Laboratory Safety Workshop, 192 Worcester Rd., Natick, MA 01760, phone 1-508-647-1900. With a $25 annual contribution, a subscription to the newsletter and free use of the A/V lending library is provided.)

National Science Teachers Association, "The Science Teacher," Membership Dept., 1742 Connecticut Ave. NW, Washington, DC 20009 (9 yearly issues for $50, incl. $12 for membership).

Rapp, M.W., "Safety Manual: A Primer for High School Chemistry Teachers," Chemistry Department, University of Central Arkansas, Conway, AR 72032.

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Appendix

Sample Safety Rules, Contracts, Incident Report, and Inspection Form

SAFETY RULES

Compiled from suggestions by Dr. Mike Rapp's UCA students

1. Goggles must be worn at all times in the laboratory area.

2. No horseplay is allowed in lab. Be considerate of others.

3. Practice good "housekeeping" techniques. Return items to proper places in good condition. Avoid cluttering work area.

4. Do not use chemicals from unlabeled containers. Check each label before dispensing a chemical. Do not return a chemical to a bottle without the teacher's permission.

5. Unless told otherwise, treat all chemicals as poisonous and/or corrosive. Wash off spills immediately with plenty of water. Always wash hands before leaving lab.

6. Food, drink, and tobacco products are not allowed in lab.

7. No unauthorized laboratory work may be done. A teacher must be present for a student to do lab work.

8. Study each lab assignment before coming to lab. Pay attention to safety notes in the lab manual and from the instructor. Some common concerns:

    a. Do not pipette by mouth.
    b. Do not use chipped or cracked glassware.
    c. Do not heat a closed system.
    d. Do not point heated containers at anyone, including yourself.
    e. Use a fume hood for any noxious fumes.
    f. Place hot glass on a wire gauze until cool.
    g. Tie back hair that is longer than shoulder length.
    h. Do not use flammable material near an open flame.
    I. Wear gloves when dispensing irritating chemicals.
    j. Dilute concentrated acids by adding acid to water.

9. Report all incidents immediately.

10. Know the location and proper use of all safety equipment in the lab.

LABORATORY SAFETY CONTRACT

Compiled from suggestions by Dr. Mike Rapp's UCA students

I _____, a responsible student in Mr./Mrs. _____ science class, agree to do my part to maintain a safe laboratory environment for myself and others. I understand and will abide by the following conditions:

1. Follow instructor's directions.
2. Wear eye protection whenever lab chemicals are present.
3. Wear gloves and other protection when advised.
4. Follow good housekeeping practices.
5. Know where emergency equipment is located.
6. Be considerate of others, act responsibly, and NO horseplay.

I have read and agree to follow the above rules while in the laboratory.

_____

(Signed and Dated by Student)

Parent/Guardian Contract

I, _____, as parent or legal guardian of _____, have read the above contract with my child. I support the instructor's effort to achieve a safe laboratory, and will encourage my child to uphold his/her part of the above agreement.

_____

(Signed and Dated)

LABORATORY INCIDENT REPORT

Compiled from suggestions by Dr. Mike Rapp's UCA students

Prepared by: _____ Date/Time:_____

Date of incident: _____ Time of incident:_____

Person(s) involved:

Room: _____ Class: _____ Instructor:

Description of the incident: (Include contributing factors, do not assign blame.)

Where was the instructor when the incident occurred?

What cautions or warnings were given before the activity started?

Any other comments:

(Prepare a sketch on the back side of this sheet and/or attach photographs. Place physical evidence in safe storage.)

_____ _____

Student Signature Date Student Signature Date

_____ _____

Instructor Signature Date Witness Signature Date

LABORATORY INSPECTION FORM

Compiled from suggestions by Dr. Mike Rapp's UCA students

Evaluate your facilities in terms of each of the following. When you have identified deficiencies, send a request to your principal for correction. Keep a copy of the request. Do not perform lab activities if the facilities are not safe.

___ unobstructed exits from the laboratory	___ good housekeeping (no clutter)
___ sufficient, accessible lab stations	___ equipment in good repair
___ safety shower & eye-wash	___ fire extinguisher & blanket
___ spill kit	___ safety rules posted
___ protective measures enforced	___ hazard communication plan
___ record keeping	___ separate, secure chemical storage
___ acceptable storage plan	___ adequate labeling
___ chemical inventory	___ material safety data sheets
___ restricted amounts of chemicals	___ master shut-offs.

The Arkansas Department of Labor will require each school to have a plan on file which describes the school's policies regarding chemical safety. A model plan can be obtained from Flinn Scientific, but schools should only include those policies which it is able to follow. For additional information contact the Arkansas Department of Labor, 10421 West Markham, Little Rock, AR 72205, (501) 682-4500.

REQUEST FOR ASSISTANCE IN DISPOSAL OF WASTE OR HAZARDOUS CHEMICALS

SUPERINTENDENT'S NAME: _____ PHONE: _____

SCHOOL NAME: _____ PHONE: _____

SCHOOL DISTRICT NAME: _____

ADDRESS: _____

CITY: _____ ZIP: _____

CHEMISTRY TEACHER'S NAME(S): _____

CHEMICAL NAME OR DESCRIPTION OF UNKNOWN	LIQUID OR SOLID	APPROXIMATE AMOUNT	IF LIQUID - WHAT CONCENTRATION	DESCRIPTION & CONDITION OF CONTAINER

RETURN TO: HAZARDOUS WASTE DIVISON
ARKANSAS DEPARTMENT OF POLLUTION CONTROL & ECOLOGY
8001 NATIONAL DRIVE, LITTLE ROCK, AR 72209
(501) 682-0874

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Office of Educational Research and Improvement (OERI)
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